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Abstract: PURPOSE: Long-term impairment of quality of life (QoL) occurs in a subset of meningioma patients, even after curative surgical resection. We sought to explore socioeconomic burden of meningioma surgery and associations with post-operative QoL to identify patients at risk for inferior outcome. METHODS: All patients with histological diagnosis of an intracranial meningioma treated at a single institution 2000-2013 were screened for inclusion in this cross-sectional survey study. Surveys comprised tools to assess socioeconomic status including social deprivation, QoL and symptom burden. Multivariate binary regression models controlling for established prognostic factors were applied to explore associations of socioeconomics with QoL 1 year after surgery. RESULTS: Completed surveys were returned by 249 patients. The median age at diagnosis was 56 years (SD ± 12), 185 patients (74%) were female and 219 (88%) had World Health Organization grade I meningiomas. One year after surgery, there was a 20% decrease in the number of patients working ($p < 0.001$), 22% of full-time working patients transitioned to part-time work ($p < 0.001$) and more patients depended on professional care (14% versus 4%, $p < 0.001$). Patients reported improved QoL, including improved global health (effect: 21%, 95% confidence interval [1] 15-26%), headaches (effect: 19%, CI 13-24%) and seizures (effect: 12%, CI 8-17%). On multivariable analyses, QoL after meningioma surgery was associated with preoperative employment status (odds ratio [OR] 0.41, 95% CI 0.17-0.98) and subjective work ability (OR 0.37, 95% CI 0.15-0.92). CONCLUSION: In a subset of meningioma patients, there is marked socioeconomic burden, which may be associated with inferior patient-reported outcome.

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Abstract

Purpose: Long-term impairment of quality of life (QoL) occurs in a subset of meningioma patients, even after curative surgical resection. We sought to explore socioeconomic burden of meningioma

surgery and associations with post-operative QoL, seeking to identify patients at risk for inferior outcome.

Methods: All patients with histological diagnosis of an intracranial meningioma treated at a single institution 2000-2013 were screened for inclusion in this cross-sectional survey study. Surveys comprised tools to assess socioeconomic status including social deprivation, QoL and symptom burden. Multivariate binary regression models controlling for established prognostic factors were applied to explore associations of socioeconomics with QoL one year after surgery.

Results: Completed surveys were returned by 249 patients. The median age at diagnosis was 56 years (SD +/-12), 185 patients (74%) were female and 219 (88%) had World Health Organization grade I meningiomas. One year after surgery, there was a 20% decrease in the number of patients working ($p<0.001$), 22% of full-time working patients transitioned to part-time work ($p<0.001$) and more patients depended on professional care (14% versus 4%, $p<0.001$). Patients reported improved QoL, including improved global health (effect: 21%, 95% confidence interval [1] 15-26%), headaches (effect: 19%, CI 13-24%) and seizures (effect: 12%, CI 8-17%). On multivariable analyses, QoL after meningioma surgery was associated with preoperative employment status (odds ratio [OR] 0.41, 95% CI 0.17-0.98) and subjective work ability (OR 0.37, 95% CI 0.15-0.92).

Conclusions: In a subset of meningioma patients, there is marked socioeconomic burden, which may be associated with inferior patient-reported outcome.

Introduction

The clinical course of meningioma patients is often benign and treatment intensity moderate, comprising neurosurgery alone in most cases [1, 2]. Quality of life and symptom burden improve after meningioma resection in the majority of patients, including a reduction in pain and discomfort or anxiety [3-5], but a subset of meningioma patients experience a long-term decrease in quality of life [3, 6, 7], particularly in the social and emotional functioning domains [7, 8]. Factors associated with post-operative quality of life include age, symptom burden, histological tumor grade, tumor size and extent of resection [4, 7].

Associations of lower socioeconomic status with unfavorable outcome has been reported from pediatric and unselected brain tumor patients [9, 10], but in meningioma patients, putative interactions of socioeconomics with quality of life have not been studied in detail.

To explore this possibility, we conducted a cross-sectional survey study in a clinically well-characterized cohort of meningioma patients. The primary objective of our study was to address the question whether or not socioeconomics should be assessed along with quality of life in prospective studies of meningioma and potentially other brain tumor patients. A more thorough understanding of the factors that determine quality of life will eventually improve the identification and supportive care of patients at risk for deterioration of quality of life.

Patients and methods

Subject selection and study design

This cross-sectional survey study was approved by the local ethics committee and was performed in accordance with the Declaration of Helsinki (IRB No. 2015-00130). Figure 1 details the primary analysis population. All patients with histologically confirmed intracranial meningioma treated at the University Hospital Zurich between 2000-2013 and with a follow-up of at least 1 year were screened for inclusion. The analysis period was determined by the introduction of an electronic chart system at this institution in the year 2000. Among 729 patients matching these criteria, 320 patients were not included in the study because at the time-point of survey distribution they were

either lost to follow-up (N=196) or had died (N=124). Surveys were sent to all 409 eligible patients in August 2016 to retrospectively explore their quality of life and socioeconomic status.

Subject information and consent

Patients who were still alive were informed that his/her medical records may be examined by authorized individuals other than their treating physician. Along with questionnaires on quality of life and socioeconomic parameters, patients and their general practitioners received a subject information sheet which explained the nature of the study and its purpose. Each subject was informed that the participation in the study is voluntary and that he/she may withdraw from the study at any time and that withdrawal of consent will not affect his/her subsequent medical treatment.

Return of questionnaires by patients was considered consent with the further use of the data provided by the patient. Concerning the further use of already available clinical data that were obtained from the patients' general practitioners, the lack of refusal of further use of their clinical data by the patient was considered consent. In the case of patients who have died or who were unable to respond or who were lost to follow-up, no consent was sought in accordance with local legislation for the following reasons: (1) In a majority of patients the tumor resection dated back several years, thus making it impossible or disproportionately difficult to obtain consent or to provide information on the right to dissent. (2) The interests of research outweigh the interests of the person concerned in deciding on the further use of his or her data, because results from the planned analyses were likely to have immediate implications for future patients.

Variables

Demographics and clinical data have been annotated and defined previously [11, 12]. Surveys were sent to eligible patients in April 2016 and comprised level of education, profession, employment status, subjective work ability, monthly income, an eleven-item socioeconomic assessment tool to quantify material and social deprivation (EPICES, Evaluation of deprivation and health inequalities in healthcare clinics) [13], quality of life utilizing the European Organization for Research and Treatment of Cancer (EORTC) quality of life questionnaire C30 (QLQ-C30) and brain tumor module BN20 [14], and symptom burden utilizing the MD Anderson Symptom Inventory Brain Tumor (MDASI-BT) [15]. The EPICES questionnaire uses eleven weighted questions to evaluate

material and social deprivation. A score of 30 or higher corresponds to relevant deprivation [16]. The EORTC QLQ-C30 assesses health-related quality of life including global health status, five functional scales and a number of scales and items assessing additional symptoms commonly reported by cancer patients [14]. It is supplemented by the EORTC QLQ-BN20 that includes four functional scales and seven symptom items to additionally assess quality of life parameters of importance to patients with brain cancer [14]. The MDASI-BT measures the patient reported symptom burden and interference with daily life by assessing the severity of 13 symptoms and by adding six questions of interference with different aspects of patients' life. Symptom items were grouped into previously defined subcategories, including general/disease-related such as fatigue, pain, disturbed sleep or change in appearance, as well as affective, cognitive, neurological and gastrointestinal.

All questionnaires were formally adapted for retrospective interrogation on the time points at surgery and 1 year after surgery. All scales and items in the EORTC QLQ-C30/BN20 and MDASI-BT were fitted to quasi-continuous scales ranging from 0-100, with higher scores representing better quality of life and lower symptom burden. The categorical variables "Any clinically meaningful deterioration in Quality of life" and "Any clinically meaningful increase in symptom burden" were computed in addition by applying a 10% cut-off to all EORTC QLQ-C30/BN20 or MDASI-BT scales [14].

The Charlson comorbidity index (CCI) [17] was applied to quantify comorbid disease burden for the timepoint of surgery. In order to minimize missing data, items of the CCI retrieved from patients' electronic charts were complemented through information obtained from the patients' general practitioners. Comorbidities documented neither in the hospital's electronic chart system nor reported by patients' general practitioners were assumed not to be present. The level of professional care was determined through the patients' general practitioners.

Statistical methods

SPSS V23.0 (IBM) was utilized for all statistical analyses. The chi-square test was performed for analysis of nominal variables. The Mann-Whitney U test was performed for ordinal variables and for interval-scaled variables that were not normally distributed. Non-normality of continuously scaled variables including quality of life was determined utilizing the Kolmogorov-Smirnov test. Binary logistic regression was performed for multivariable testing of factors associated with

inferior quality of life. Variance inflation factors (VIF) of the regression model were determined by linear regression to test for multicollinearity, and VIF <5 were defined as no multicollinearity [18]. Linearity of independent variables was determined by Pearson's correlation and Nagelkerke's R^2 test was done to estimate the model fit. No imputation of missing data was done. No sample size estimation was done. A p-value <0.05 was considered statistically significant for any analyses. Cronbach's α-test was applied as a measure of reliability of the applied scores.

Results

Patient characteristics

Completed surveys were obtained from 249 of 409 eligible patients (61%). There were 88 patients (21%) who did not consent, 48 patients (12%) did not return the survey due to a foreign mother tongue and 24 patients (6%) due to cognitive impairment. Characteristics of the primary analysis population are summarized in Table 1. The median age at surgery was 56 years (standard deviation +/- 12 years) and 185 patients (74%) were female. The high rate of female patients with meningioma reflects the population-based gender distribution of meningioma [1]. The level of education was an apprenticeship or higher in 214 patients (86%). The most common professional background in 100 patients (40%) was employee, followed by leadership or academia in 49 patients (20%) and 40 patients (16%) were industrial or agricultural workers. Relevant comorbidities indicated by a CCI larger than 2 were present in 57 patients (23%). The vast majority of 219 patients (88%) suffered from WHO grade I meningiomas. The most common tumor location was the skull base in 89 patients (36%), followed by convexity meningiomas in 54 (22%). A radiographic gross total resection was achieved in 189 patients (76%). Ninety-nine patients (40%) suffered from any neurological deficit one year after surgery, and 31 (12%) experienced a recurrence of their meningioma during this time. Patients who did not return surveys (N=160) compared to the primary analysis population had a higher frequency of tumor recurrences one year after surgery (22%, p=0.009). There was also a trend towards higher age at surgery (p=0.059), higher WHO grade (p=0.085) and a lower rate of radiographic gross total resections (p=0.065), whereas no difference was detected with respect to gender distribution (p=0.24), tumor location (p=0.19) or presence of neurological deficits at 1 year after surgery (p=0.39, Table S1).

Socioeconomics before versus 1 year after surgery

Socioeconomic parameters before and 1 year after meningioma surgery are summarized in Table 2. There were 47 fewer patients (20%) working, including 13 patients (5%) who were unemployed, 11 patients (5%) who were disabled, and 23 patients (10%) who had retired due to age ($p<0.001$). Of 101 patients working fulltime before surgery, 21 patients (21%) had transitioned to part-time work and 24 patients (24%) had stopped working. Among 88 patients working part-time before surgery, 23 patients (26%) had stopped working. This led to an overall decrease in the patients working full time while the absolute number of patients working part time remained stable. The monthly income was unaffected in the higher income segments over 8.000 CHF per month, but 11 patients (7%) had shifted into the lowest income segment below 4.000 CHF per month ($p=0.008$), which is in the range of the guaranteed basic social security. There were 21 more patients (10%) who required professional care ($p<0.001$), which was administered as home nursing in all but 2 patients (1%).

Quality of life 1 year after surgery versus before surgery

Figure 2A summarizes changes in quality of life before versus one year after surgery of an intracranial meningioma. A clinically meaningful improvement one year after surgery was observed in individual scales of the EORTC-QLQ-C30/BN20 (defined as a $\geq$10% shift, see methods) for global health (20.7%, 95% confidence interval [1] 15.2-26.2%), headaches (18.6%, 95% CI 13.6-23.6%) and seizures (12.1%, 95% CI 7.7-16.5%). There was also a <10% improvement of emotional and social functioning, future uncertainty and of several symptom items, including nausea and vomiting, pain, appetite loss, visual disorder and motor dysfunction, whereas no worsening of any scale was observed on the population level. The MDASI-BT did not determine >10% changes in symptom burden or interference, albeit lower level improvement was noted for all scales but cognitive functioning (Figure 2B). On the patient level worsening in one or more scales of the EORTC-QLQ-C30/BN20 or the MDASI-BT one year after surgery has been reported by 178 patients (71.5%). The score reliability was confirmed for both, the EORTC-QLQ-C30/BN20 ($\alpha = 0.92$) and the MDASI-BT ($\alpha = 0.93$).

Multivariable analyses

We employed a binary regression model to explore predictors of a clinically meaningful decline in quality of life on the patient level, i.e. of any scale of the EORTC-QLQ-C30/BN20 or the MDASI-

BT one year after surgery (Table 3). The model comprised the variables age (<55 versus ≥55 years), gender (female versus male), WHO grade (I versus II/III), tumor location (other versus skull base), tumor diameter (<40 versus ≥40 mm) and presence versus absence of any neurological deficits one year after surgery. There was no multicollinearity (any VIF <5) and no linearity of independent variables except for a mild association of WHO grade and gender (R=0.15, p=0.018). Univariate analyses are summarized in Table S2. In the multivariable model, only younger age was associated with a decline in quality of life (odds ratio [OR] 2.38, 95% confidence interval [CI] 1.20-4.76, p=0.012).

We then utilized this model to explore associations of socioeconomic parameters at the timepoint of surgery with inferior outcome of quality of life. There was an association with occupational status (working versus unemployment or retirement, OR 0.41, 95% CI 0.17-0.98, p=0.049) and along the same lines a subjective work ability of at least 70% was associated with better outcome (OR 0.37, 95% CI 0.15-0.92, p=0.033). No associations were identified for level of education (p=0.95), low income (p=0.30), workload (p=0.77), or social deprivation (p=0.54).

Discussion

This cross-sectional survey study was designed to explore socioeconomic burden and associations with quality of life in meningioma patients. Our study confirms previous reports on improved quality of life after meningioma resection in the majority of patients [3, 4, 19-21]. However, associations of the diagnosis and surgery of an intracranial meningioma with socioeconomic status changes has not been studied in detail. It was striking that the surgery of meningiomas, i.e. relatively benign intracranial tumors, was followed by pronounced socioeconomic status changes in a substantial fraction of patients, including unemployment or increased dependency on care. Consistent with prior reports, e.g. on patients with multiple sclerosis [22] or a population-based analysis [23], we have also identified an association of unemployment with inferior quality of life. Our finding of an association of higher subjective work ability with better quality of life underscores the relevance of self-efficacy as a source of resilience, especially in younger neuro-oncology patients who appear to be less confident about their cognitive performance after surgery [19, 24]. Likewise, the often more aggressive disease course of meningiomas in younger patients

may have contributed to an overall more pronounced volatility of quality of life among younger patients in our cohort.

We hypothesize that even more prominent associations of socioeconomics with quality of life may be present in societies that are lacking a socialized health care system and high social security standards. Moreover, the question arises whether patients suffering from brain tumors with less favorable prognosis are likewise affected by the socioeconomic impact of their diagnosis. In fact, the quality of life of entire families is likely to be affected by the socioeconomic demands of care, treatment and rehabilitation [15]. Other factors that will probably determine quality of life include cognitive functioning and the presence of anxiety or depression [5, 7, 20, 25]. Notably, these psychiatric symptoms are not reflected by the CCI. A trend towards reduced future uncertainty and better emotional social functioning one year after surgery suggests that surgery may improve these potential confounders of quality of life, but future prospective studies should be designed to clarify putative interactions of these factors with socioeconomic burden.

An inherent limitation of the design of our study is random data loss due to unreturned surveys or return of incomplete surveys, albeit the survey return rate in our study was high, at least in part due to follow-up phone calls that were performed in patients who did not respond. We did not correct statistically for multiple testing, as recommended by Bender and Lange (2001) for exploratory studies in order to avoid false negative results [26]. We also report selection bias of our study toward patients with a more favorable disease course, including less frequent tumor recurrence, lower WHO grade and a higher rate of gross total resections. This selection might have led to an overestimation of improvement of quality of life after surgery, but also implies that socioeconomic burden may been have been underestimated. The retrospective design of our study implies that patients' quality of life at the time-point when the surveys were received has likely corroborated the results. The key valuation of our study is however unaffected by these limitations, i.e. that relevant socioeconomic burden is associated with meningioma surgery and that socioeconomics may confound outcome measures.

Conclusion

Patients with meningioma experience socioeconomic burden, which is associated with inferior quality of life. Prospective studies assessing associations of socioeconomics and quality of life are

warranted to define and meet public health challenges in meningioma patients more precisely, including a more effective assignment of psychosocial support.

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Figure legends

Figure 1. Study population.

Figure 2. Quality of life (A) and symptom burden (B) one year after versus before meningioma surgery. Forest plots depict effect sizes, defined as differences in mean values on quasi-continuous scales ranging from 0-100.

Supplemental Digital Content

Supplemental Digital Content 1. Table. Characteristics of patients who returned the surveys versus patients who did not return the surveys.

Supplemental Digital Content 2. Table. Univariate analyses of inferior quality of life one year after surgery.

Purpose: Long-term impairment of quality of life (QoL) occurs in a subset of meningioma patients, even after curative surgical resection. We sought to explore socioeconomic burden of meningioma surgery and associations with post-operative QoL, seeking to identify patients at risk for inferior outcome.

Methods: All patients with histological diagnosis of an intracranial meningioma treated at a single institution 2000-2013 were screened for inclusion in this cross-sectional survey study. Surveys comprised tools to assess socioeconomic status including social deprivation, QoL and symptom burden. Multivariate binary regression models controlling for established prognostic factors were applied to explore associations of socioeconomics with QoL one year after surgery.

Results: Completed surveys were returned by 249 patients. The median age at diagnosis was 56 years (SD +/-12), 185 patients (74%) were female and 219 (88%) had World Health Organization grade I meningiomas. One year after surgery, there was a 20% decrease in the number of patients working ($p<0.001$), 22% of full-time working patients transitioned to part-time work ($p<0.001$) and more patients depended on professional care (14% versus 4%, $p<0.001$). Patients reported improved QoL, including improved global health (effect: 21%, 95% confidence interval [1] 15-26%), headaches (effect: 19%, CI 13-24%) and seizures (effect: 12%, CI 8-17%). On multivariable analyses, QoL after meningioma surgery was associated with preoperative employment status (odds ratio [OR] 0.41, 95% CI 0.17-0.98) and subjective work ability (OR 0.37, 95% CI 0.15-0.92).

Conclusions: In a subset of meningioma patients, there is marked socioeconomic burden, which may be associated with inferior patient-reported outcome.

Table 1. Patient characteristics.

Age at diagnosis: years	
Median	56
Range	18-79
Standard deviation	12
Gender: N (%)	
Female	185 (74)
Male	64 (26)
Highest level of education: N (%)	
No school education	2 (1)
School education	27 (11)
Apprenticeship	138 (55)
Higher education	76 (31)
Unknown	6 (2)
Profession: N (%)	
Leadership or academic	49 (20)
Employee	100 (40)
Industry worker or agriculture	40 (16)
Other	60 (24)
Charlson Comorbidity Index (CCI): N (%)	
CCI ≤ 2	192 (77)
CCI 3-4	50 (20)
CCI ≥ 5	7 (3)
WHO grade: N (%)	
I	219 (88)
II / III	30 (12)
Location: N (%)	
Multiple meningiomas	31 (12)
Convexity	54 (22)
Parasagittal / falx	35 (14)
Skull base	89 (36)
Posterior fossa	33 (13)

Other	7 (3)
Extent of resection: N (%)	
Gross total Incomplete No data	189 (76) 49 (20) 11 (4)
Neurological deficits 1 year after surgery: N (%)	
Yes No	99 (40) 150 (60)
Tumor recurrence within 1 year after surgery: N (%)	
Yes No	31 (12) 218 (88)

Table 2. Socioeconomics before versus one year after surgery.

	At surgery	One year after surgery	
Occupation: N (%)[a]			p
Working	189 (78)	142 (58)	<0.001
Unemployed	7 (3)	20 (8)	
Retired	39 (16)	62 (26)	
Disabled	8 (3)	19 (8)	
related to diagnosis			
Yes	*3 (1)*	*14 (6)*	
No	*5 (2)*	*5 (2)*	
Workload: N (%)[a]			
full time	101 (42)	56 (23)	<0.001
part time	88 (36)	86 (35)	
not working	54 (22)	101 (42)	
Monthly income: Swiss Francs[b]			
< 4000	54 (32)	65 (39)	0.008
4000-8000	83 (50)	73 (44)	
8000-12'000	21 (13)	21 (13)	
>12'000	8 (5)	7 (4)	
Subjective work ability: % [c]			
Mean	73	72	0.55
95% CI	69-77	67-76	
Standard deviation	2.6	2.8	
Care dependency: N (%)[d]			
No professional care	214 (96)	193 (86)	<0.001
Care at home	9 (4)	28 (13)	
Nursing home	0 (0)	2 (1)	
Social deprivation (EPICES score ≥ 30) [e, f]			
No	123 (70)	124 (71)	1.000
Yes	53 (30)	52 (30)	

[a] data available for 243 patients [b] data available for 166 patients [c] data available for 146 patients

[d] data available for 223 patients [e] data available for 176 patients

[f] Cronbach's alpha = 0.96

Table 3. Multivariable model of inferior quality of life one year after surgery.[#]

	Odds ratio and 95% CI	**p**
Age: <55y versus ≥55y	2.38 (1.20;4.76)	0.012*
Gender: female versus male	1.56 (0.77;3.13)	0.22
WHO grade: I versus II/III	1.16 (0.33;2.50)	0.84
Location: other versus skullbase	0.67 (0.34;1.33)	0.26
Diameter: <40mm versus ≥40mm	0.57 (0.29;1.12)	0.11
Postoperative neurological deficit: no versus yes	0.75 (0.38;1.47)	0.40
Socioeconomic parameters at diagnosis[+]		
Highest level of education: Apprenticeship or higher versus school or lower	1.02 (0.50;2.10)	0.95
Occupation: working versus unemployed or retired	0.41 (0.17;0.98)	0.049*
Monthly income: >4000 versus ≤4000 CHF	0.63 (0.26;1.52)	0.30
Workload: part-time versus full-time	0.88 (0.38;2.03)	0.77
Subjective work ability: ≥70 versus <70 %	0.37 (0.15;0.92)	0.033*
Social deprivation: EPICES <30 versus ≥30	2.79 (0.98;7.91)	0.54

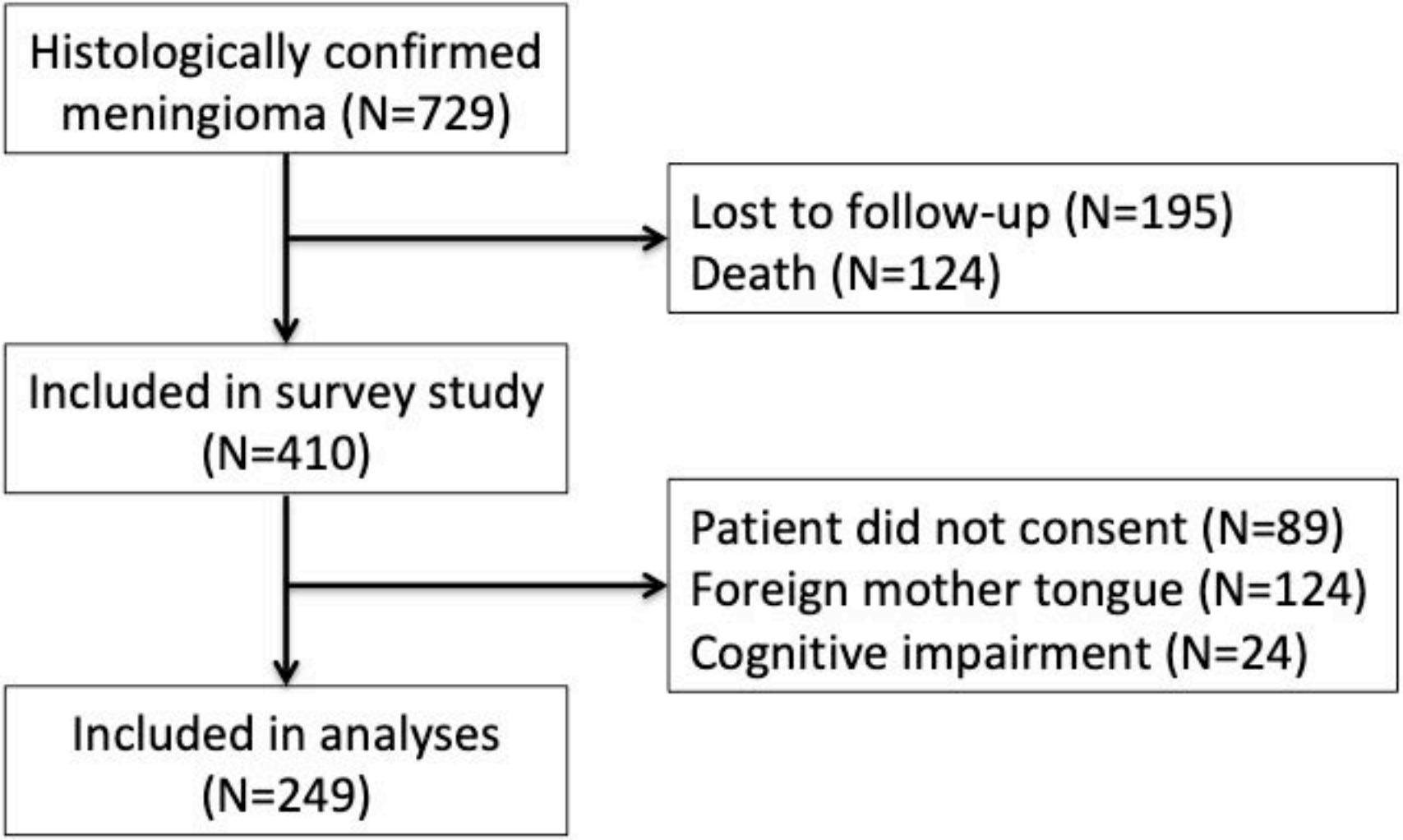
[#] complete datasets were available from 192 patients; [+] tested as additional single variables; * $p<0.05$

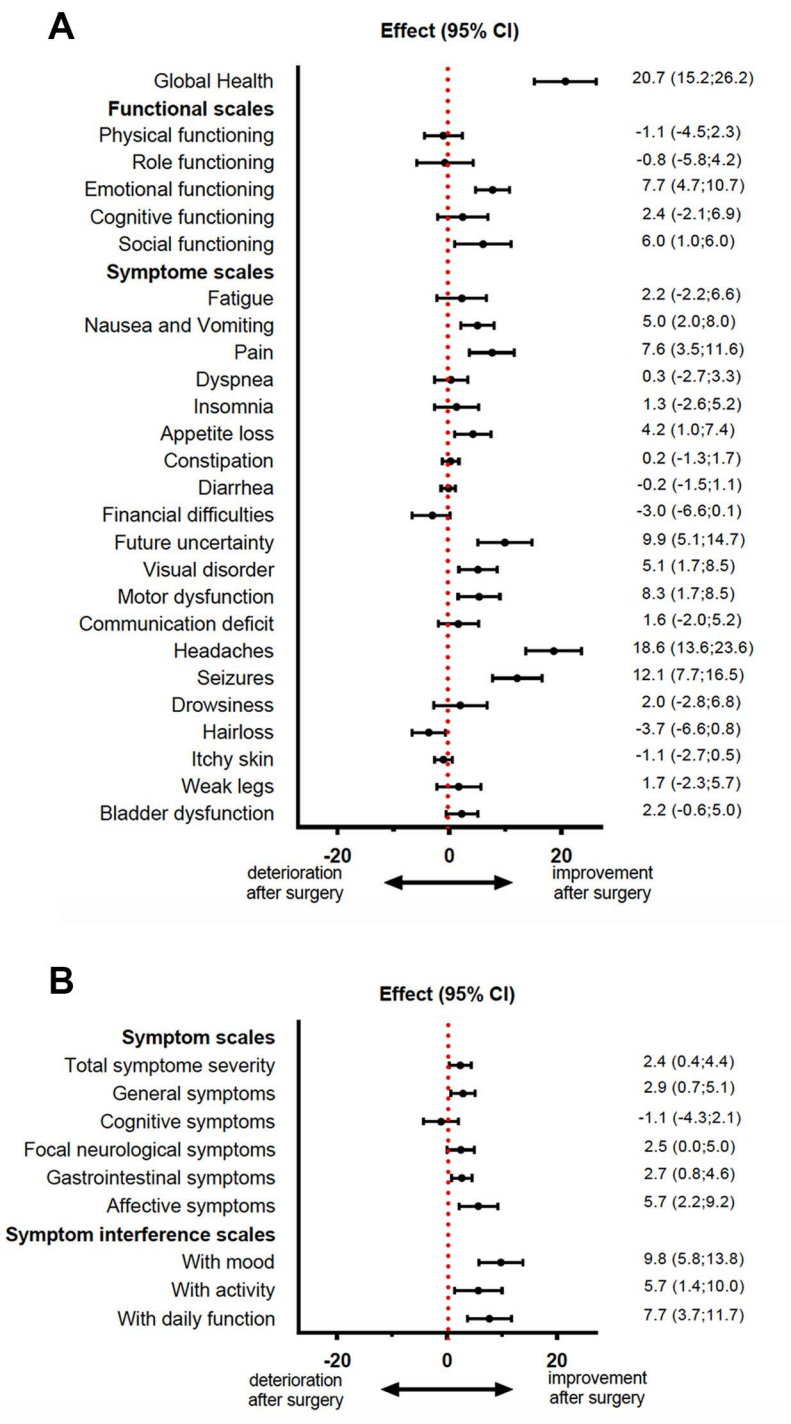
Table S2. Univariate analyses of inferior quality of life one year after surgery.

	Odds ratio and 95% CI	p
Age: <55y versus ≥55y	1.56 (0.89;2.75)	0.12
Gender: female versus male	1.60 (0.86;2.96)	0.14
WHO grade: I versus II/III	0.95 (0.40;2.24)	0.90
Location: other versus skullbase	0.70 (0.38;1.30)	0.26
Diameter: <40mm versus ≥40mm	0.74 (0.41;1.34)	0.32
Postoperative neurological deficit: no versus yes	0.64 (0.36;1.16)	0.14
Socioeconomic parameters at diagnosis		
Highest level of education: Apprenticeship or higher versus school or lower	0.90 (0.49;1.65)	0.74
Occupation: working versus unemployed or retired	0.64 (0.31;1.33)	0.23
Monthly income: >4000 versus <4000 CHF	1.10 (0.55;2.22)	0.78
Workload: part-time versus full-time	1.05 (0.56;1.99)	0.88
Subjective work ability: >70 versus <70 %	0.56 (0.27;1.19)	0.13
Social deprivation: EPICES <30 versus >30	0.63 (0.30;1.37)	0.24

Table S1. Characteristics of patients who returned the surveys versus patients who did not return the surveys.

	Surveys returned	Surveys not returned	p
Age at diagnosis (years)			
Mean	56	59	0.016
Range	18-79	18-88	
Gender: N (%)			
Female	185 (74)	316 (66)	0.012
Male	64 (26)	164 (34)	
WHO grade: N (%)			
I	219 (88)	376 (78)	0.001
II / III	30 (12)	104 (22)	
Tumor location: N (%)			
Multiple meningiomas	31 (12)	27 (17)	0.19
Convexity	54 (22)	35 (22)	
Parasagittal / falx	35 (14)	30 (19)	
Skull base	89 (36)	54 (33)	
Posterior fossa	33 (13)	13 (8)	
Other	7 (3)	1 (1)	
Extent of resection: N (%)			
Gross total	189 (76)	332 (69)	0.079
Incomplete	49 (20)	115 (24)	
No data	11 (4)	33 (7)	
Neurological deficits 1 year after surgery: N (%)			
Yes	78 (31)	53 (33)	0.39
No	171 (69)	107 (67)	
Tumor recurrence within 1 year after surgery: N (%)			
Yes	31 (12)	125 (26)	<0.001
No	218 (88)	355 (74)	


Histologically confirmed meningioma (N=729)
Lost to follow-up (N=195)
Death (N=124)
Included in survey study (N=410)
Patient did not consent (N=89)
Foreign mother tongue (N=124)
Cognitive impairment (N=24)
Included in analyses (N=249)


A
Effect (95% CI)
Global Health
Functional scales
Physical functioning
Role functioning
Emotional functioning
Cognitive functioning
Social functioning
Symptome scales
Fatigue
Nausea and Vomiting
Pain
Dyspnea
Insomnia
Appetite loss
Constipation
Diarrhea
Financial difficulties
Future uncertainty
Visual disorder
Motor dysfunction
Communication deficit
Headaches
Seizures
Drowsiness
Hairloss
Itchy skin
Weak legs
Bladder dysfunction
20.7 (15.2;26.2)
-1.1 (-4.5;2.3)
-0.8 (-5.8;4.2)
7.7 (4.7;10.7)
2.4 (-2.1;6.9)
6.0 (1.0;6.0)
2.2 (-2.2;6.6)
5.0 (2.0;8.0)
7.6 (3.5;11.6)
0.3 (-2.7;3.3)
1.3 (-2.6;5.2)
4.2 (1.0;7.4)
0.2 (-1.3;1.7)
-0.2 (-1.5;1.1)
-3.0 (-6.6;0.1)
9.9 (5.1;14.7)
5.1 (1.7;8.5)
8.3 (1.7;8.5)
1.6 (-2.0;5.2)
18.6 (13.6;23.6)
12.1 (7.7;16.5)
2.0 (-2.8;6.8)
-3.7 (-6.6;0.8)
-1.1 (-2.7;0.5)
1.7 (-2.3;5.7)
2.2 (-0.6;5.0)
-20
0
20
deterioration after surgery
improvement after surgery
B
Effect (95% CI)
Symptom scales
Total symptome severity
General symptoms
Cognitive symptoms
Focal neurological symptoms
Gastrointestinal symptoms
Affective symptoms
Symptom interference scales
With mood
With activity
With daily function
2.4 (0.4;4.4)
2.9 (0.7;5.1)
-1.1 (-4.3;2.1)
2.5 (0.0;5.0)
2.7 (0.8;4.6)
5.7 (2.2;9.2)
9.8 (5.8;13.8)
5.7 (1.4;10.0)
7.7 (3.7;11.7)
-20
0
20
deterioration after surgery
improvement after surgery